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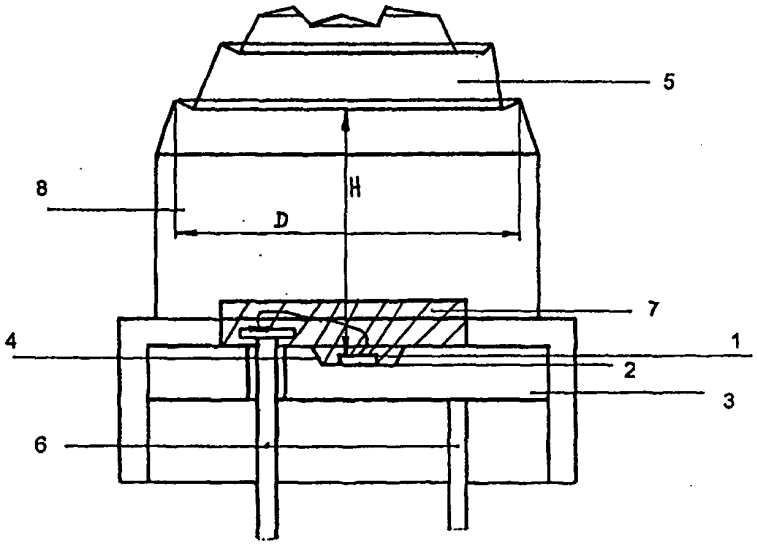
(54) Title: LUMINESCENT DIODE DEVICE



(57) Abstract

The invention falls within the realms of electronic engineering specifically of the luminescent diode devices and is intended for application in semi-conductor industries. The luminescent diode device contains crystals of light emitter located in a recess of a substrate having a reflecting side surface and also a concentrating lens. The lens is executed in the form of raster of annular and line elements or of the combination thereof, plotted on the flat conical surface or on the surface of second sequence or on the combination thereof. The angles of inclination of generatrixes to the optical axis of lens are keeping within the limits of 0 up to +/- 90.

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LUMINESCENT DIODE DEVICE.

The invention relates to the field of electronic engineering, namely to semi-conducting devices containing several elements executed on the common substrate, specifically to luminescent diodes and can find its application in the semi-conductor industry in development and manufacture of the luminescent diode devices used in power engineering, railway traffic, ferrous metallurgy, chemical industry, heavy and other industries.

Luminescent diodes are widely used in signaling about the mode of operation of various devices, in full-coloured screens of public use of any format, in manufacture of such sources of information as information panels, traveling lines, traffic lights, additional signals of braking in automobiles, etc.

The use of luminescent diodes instead of incandescent lamps considerably increases the reliability and reduces the power consumption of equipment. As this takes place, in many cases required are the luminescent diodes with a wide range of colours and shades of light flow, varying in size and uniformity of luminous spot and in emissive power (luminous intensity).

The most important parameter of luminescent diodes is the emissive power depending mostly on the strength of flowing forward electrical current and on the value of thermal resistance of the holder on which a crystal of light emitter is installed.

If taking into consideration the technical essence, the closest one to the offered luminescent diode device is a device containing the crystals of light emitter placed in the recess of substrate which has a reflecting side surface and also a concentrating lens (International patent Application № PCT/RU97/00070, International Publication № WO98/42031 dated 24.09.98). The drawback of such device is the lack of concentration of emission directionality and low light intensity.

The technical result of the offered invention is increasing of emissive power (luminous intensity) of the luminescent diode with possibility of varying of an angle of vision and of spatial diagram of emission directionality.

The set task is solved through that the luminescent diode contains the crystals of light emitter placed in the recess of substrate having the light-reflecting side surface, and also a concentrating lens. The lens is executed in the form of a

raster of annular and line elements, or combination thereof, plotted on the flat conical surface or on the surface of second sequence or on the combination thereof, meanwhile the angles of inclination of generatrixes towards the optical axis of lens are keeping within the limits of 0 ° up to +/- 90°. The ratio of diameter of each element of the lens raster structure to the distance from this element to the crystal is keeping within the limits of 0,2 up to 5. The ratio of the depth of substrate recess to the thickness of crystals is (2 - 4): 1. Each crystal is located in a mounting seat the value of diameter whichof does not exceed the size of diagonal of the lower face of the corresponding crystal in more than one and a half times.

Schematically shown in Figure 1 is the offered luminescent diode device.

Shown in Figure 2 is the view of the device from below.

The luminescent diode device contains crystals (1) of light emitter installed in a recess (2) of the substrate (3) which has reflecting side surface (4). The device contains also a concentrating lens (5) which is executed in the form of a raster. The raster consists of annular and line elements, or combination thereof, plotted on the flat conical surface or on the surface of second sequence or on the combination thereof (5). The angles of inclination of generatrixes towards the optical axis of lens are keeping within the limits of 0 ° up to +/- 90°.

The ratio of diameter of each element of the lens raster structure (5) to the distance from this element to the crystal (1) is keeping within the limits of 0,2 up to 5.

The ratio of the depth of recess (2) of substrate (3) to the thickness of crystals (1) is (2 - 4): 1. Each crystal is located in a mounting seat the value of diameter whichof does not exceed the size of diagonal of the lower face of the corresponding crystal (1) in more than one and a half times.

The work of the luminescent diode device can be described as follows.

When the electrical voltage which ensures the flow of forward current through the crystal (1) of the light emitter (5) is supplied to the connecting outlets (6), the crystal (1) begins to emit light. The emission from the upper surface of the crystal (1) of light emitter and from its lateral faces after reflecting by the truncated conical surface (4) of the recess (2) falls on a layer of polymeric sealing compound

(hermetic) (7) and after that, on the concentrating lens (5) forming the emission of required indicatriss.

Depending on the required diagram of directionality of emission a corresponding configuration of lens is applied. Availability of polymeric sealing compound (hermetic) (7) and of the cylindrical base (8) of the lens (5) ensures reduction of emission intensity losses and also the required diagram of emission directionality. Furthermore, the polymeric sealing compound (hermetic) (7) ensures the protection of the crystals (1) of the light emitters from penetration of humidity.

The depth of the flat mounting seat for crystals (1) of light emitters exceeds the thickness of the crystal but does not exceed four thicknesses of the crystals. The size of the mounting seat of the crystals (1) of light emitters exceeds the size of diagonal of its lower face (1,5-2 times) which finally makes possible to gather totally (to concentrate) the emission along the optical axis of the luminescent diode and ensures high dispersion of consumed power from the lower face of substrate.

The crystals (1) of light emitters with red, orange, yellow, green, blue and dark blue colours of luminescence may be used in monochromatic one-coloured version of the luminescent diode.

The construction of concrete luminescent diode device made in accordance with the present invention contains a metallic-glass holder of steel 1 mm thick, with connected outlets 0,55 mm in diameter. Reflecting truncated conical surface has a depth of 0,6 mm, diameter on the substrate surface is equal to 2,4 mm, diameter of the flat bottom equipped with mounting seats for crystals is 1,5 mm. The cover is cast in plastic mass - polycarbonate of «Lexan» type. A sealing (polymeric) compound of 159-322 make is used.

Crystals emitting red light with wave 633 nm in length, green light with wave 525 nm in length and dark blue light with wave 470 nm in length served as crystals of light emitter. To install the crystals of light emitters and to coat the junctions of the conductors to isolated connecting outlets based on silver a current-transmitting glue of TOK-2 type was applied.

Described construction of the luminescent diode device ensures thermal resistance to be 170 ° C/W and increasing of the forward current, flowing through

the luminescent diode, up to 80 mA without losses of linearity of lux-ampere characteristic. This makes possible to obtain luminous intensity more than 60 Cd at carbon temperature 3°.

Shown below are the properties/characteristics of super-bright full-coloured luminescent diodes developed on the base of the present invention.

The said devices contain light emitter crystals (of red, green and dark blue colours) mounted in hermetic plastic corpse with a square base and plastic cover -

Examples of concrete execution of the offered luminescent diode device may be illustrated in Table 1 and Table 2.

Shown in Table 1 are properties/characteristics of bright semi-conductor luminescent diodes.

Table 1

Type of device	Lens colour	Length of wave /nm	Luminous intensity Idev.=40 mA Min mCd	Luminous intensity Idev.=40 mA Type mCd	Angle of emission 2θ ½I_v degr.
SID-F	transparent	630	72000	90000	3
		525	85000	98000	3
		470	25000	30000	3

Shown in Table 2 are maximum operating properties/characteristics and other properties of semi-conducting luminescent diodes.

Table 2.

№	Maximum parameters at 25°C	
1.	Maximum limit forward current	300 mA
2.	Average forward current	60 mA
3.	Maximum forward current	70 mA
4.	Dispersed intensity	300 mW
5.	Reverse voltage (at reverse current=100 mkA)	5 V
6.	Operating temperature	-55 up to + 100°C
7.	Temperature of casting by lead solder (1,6 mm from cover)	260°C in 5 seconds

As one can conduct from the present specification of invention and from concrete examples of construction thereof the developed luminescent diode device can find its wide industrial application.

CLAIMS

1. The luminescent diode device containing crystals of light emitter located in a recess of a substrate having a light-reflecting side surface and also a concentrating lens, wherein the lens is executed in the form of raster of annular and line elements or of the combination thereof, plotted on the flat conical surface or on the surface of second sequence or on the combination thereof and as this takes place the angles of inclination of generatrixes to the optical axis of lens are keeping within the limits of 0° up to +/- 90°.

2. The luminescent diode device as defined in Claim 1, wherein the ratio of diameter of each element of the raster structure of lens to the distance from this element to the crystal is keeping within the limits of 0,2 up to 5.

3. The luminescent diode device as defined in Claim 1, wherein the ratio of the substrate recess depth to the thickness of crystals is (2 - 4): 1.

4. The luminescent diode device as defined in Claim 1, wherein each crystal is installed in a mounting seat, the diameter whichof does not exceed the size of diagonal of the lower face of the corresponding crystal in more than one and a half times.

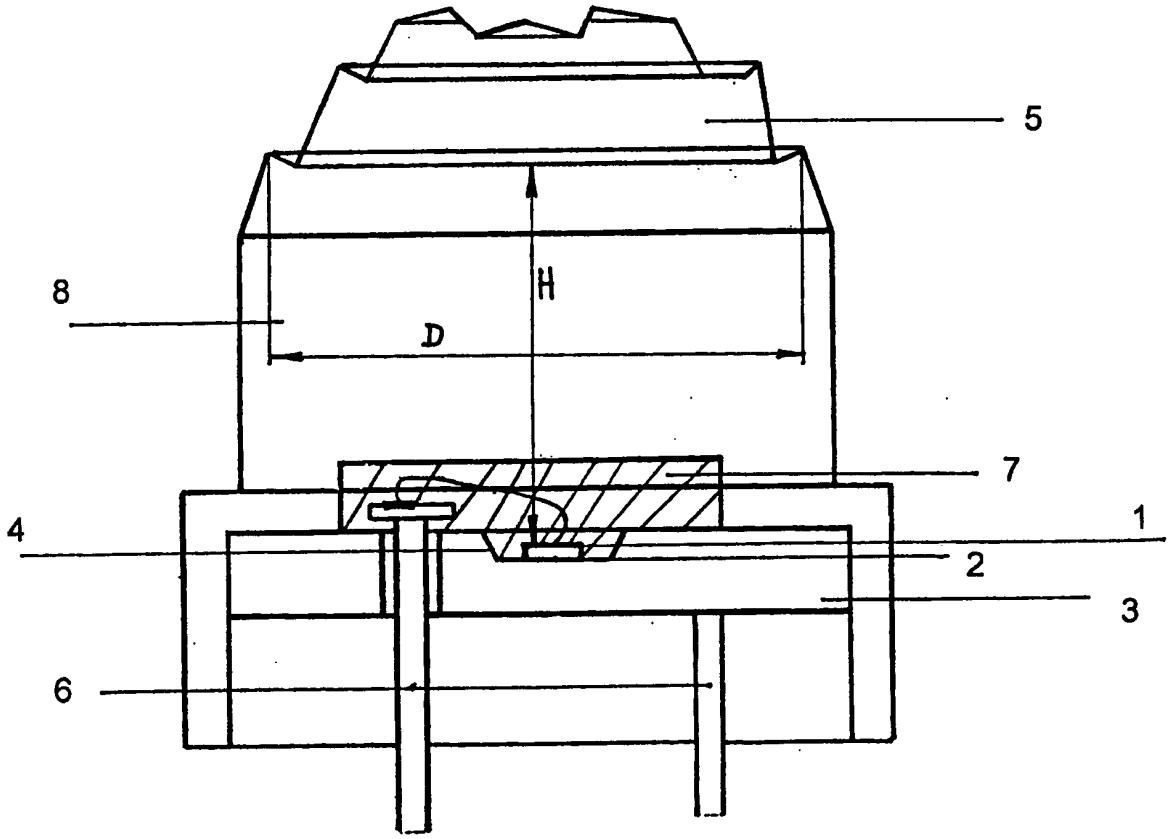

Fig.1

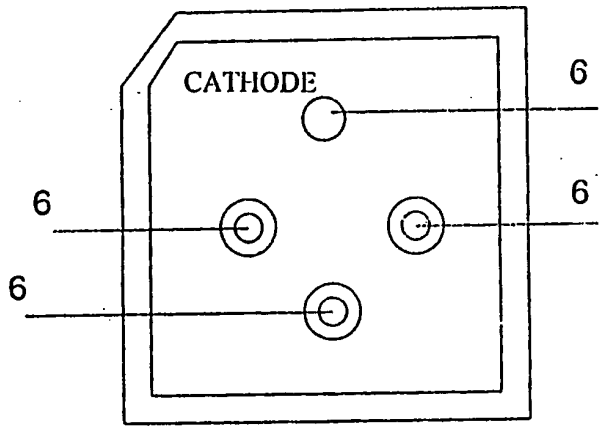

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 99/00388

A. CLASSIFICATION OF SUBJECT MATTER
H01L 33/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
H01L 33/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched:

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
X	RU 2134000 C1 (АБРАМОВ В.С. и др.) 27.07.99, claims	1
Y		1, 3, 4
Y	RU 2133068 C1 (АБРАМОВ В.С. и др.) 10.07.99, claims	1, 3, 4
A	DE 19535777A1 (SIEMENS AG) 27. 3.97	1-4
A	RU 2114492 C1 (АБРАМОВ В.С. и др.) 27.06.98	1-4
A	US 5528057 A (OMRON CORPORATION) Jun. 18, 1996	1-4

☐ urther documents are listed in the continuation of Box C. ☐ See patent family annex

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30 May 2000 (30.05.2000)	13 July 2000 (13.07.2000)
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INTERNATIONAL SEARCH REPORT

International application No.
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Box 111 TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

The invention falls within the realms of electronic engineering specifically of the luminescent diode devices and is intended for application in semi-conductor industries.

The luminescent diode device contains crystals of light emitter located in a recess of a substrate having a reflecting side surface and also a concentrating lens. The lens is executed in the form of raster of annular and line elements or of the combination thereof, plotted on the flat conical surface or on the surface of second sequence or on the combination thereof. The angles of inclination of generatrixes to the optical axis of lens are keeping within the limits of O up to +/- 90.